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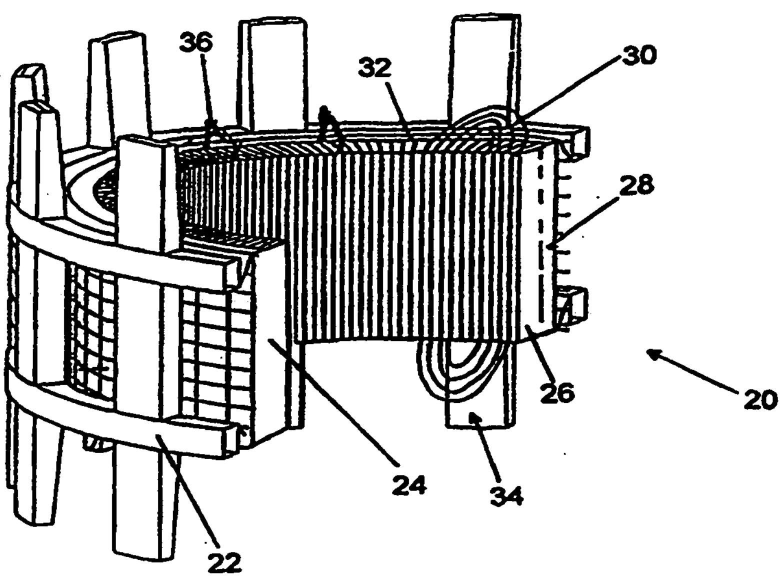

(57) Abstract

The present invention relates to a stator (20) in a rotating electric machine, a method for manufacturing a stator (20) for a rotating electric machine, and a rotating electric machine incorporating a stator (20) of the type described. The rotating electric machine is provided with windings (30) drawn through slots in the stator (20). The stator (20) is composed of a stator body (22), a stator core (24) comprising stator teeth (26) extending radially inwards from an outer yoke portion (28). The stator core (24) consists of a number of pack (38), each of which includes a number of metal sheets, or of a number of metal sheets (38), each pack (38) or metal sheet (38) being stacked on top of and partially overlapping each other, said packs (38) or metal sheets (38) being secured radially by means of wedge members (110) arranged at the stator body (22). The packs (38) or metal sheets (38) are secured axially by means of hot-setting adhesive members (90; 96) arranged between them, and the windings (30) consist of high–v ltage cable (10).

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A STATOR AND A METHOD FOR MANUFACTURING THE SAME

Technical field:

The present invention relates in a first aspect to a stator in a rotating electric machine.

In a second aspect the present invention relates to a method of manufacturing a stator for a rotating electric machine.

In a third aspect the present invention relates to a rotating electric machine incorporating a stator of the type described.

The machine is in the first place intended as generator in a power stator for generating electric power.

The invention is applicable to rotating electric machines such as synchronous machines and normal asynchronous machines. The invention is also applicable to other electric machines such as dual-fed machines, and to applications in asynchronous static current converter cascades, provided their windings are made up of insulated electric conductors, preferably operating at high voltages. By high voltages is meant in the first place electric voltages in excess of 10 kV. A typical working range for the device according to the invention may be 36 kV-800 kV.

The invention is in the first place intended for use with a high-voltage cable of the type built up of an electric conductor composed of one or more strand parts, a first semiconducting layer surrounding the electric conductor, an insulating layer surrounding the first semiconducting layer, and a second semiconducting layer surrounding the insulating layer, and its

advantages are particularly marked here. The invention refers particularly to such a cable having a diameter within the interval 20-200 mm and a conducting area within the interval 80-3000 mm^2.

Such applications of the invention thus constitute preferred embodiments thereof.

Background art:

Similar machines have conventionally been designed for voltages in the range 15-30 kV, and 30 kV has normally been considered to be an upper limit. This generally means that a generator must be connected to the power network via a transformer which steps up the voltage to the level of the power network, i.e. in the range of approximately 130-400 kV.

By using high-voltage insulated electric conductors, in the following termed high-voltage cables, with solid insulation similar to that used in cables for transmitting electric power (e.g. XLPE cables) the voltage of the machine can be increased to such levels that it can be connected directly to the power network without an intermediate transformer. The conventional transformer can thus be eliminated. The concept generally requires the slots in which the cables are placed in the stator to be deeper than with conventional technology (thicker insulation due to higher voltage and more turns in the winding).

A conductor is known through US 5 036 165, in which the insulation is provided with an inner and an outer layer of semiconducting pyrolized glassfiber. It is also known to provide conductors in a dynamo-electric machine with such an insulation, as described in

US 5 066 881 for instance, where a semiconducting pyrolized glassfiber layer is in contact with the two parallel rods forming the conductor, and the insulation in the stator slots is surrounded by an outer layer of semiconducting pyrolized glassfiber. The pyrolized glassfiber material is described as suitable since it retains its resistivity even after the impregnation treatment.

Conventional types of rotating electric machines are disclosed and described in the book titled "Elektriska Maskiner", by Fredrik Gustavson, page 6-1 to 7-32, published by KTH 1996.

In conventional types of rotating electric machines the stator body often consists of a welded construction (whole stator body) or welded and screwed steel plate constructions (divided stator body). In large machines, the stator core, also known as (magnetic) laminated core, is generally made up of metal sheets of core sheet 0.35 mm or 0.5 mm thick. Sheets of suitable size are punched out and have punched or cut openings and/or holes. The stator core can be built up by placing the metal sheets in a ring, layer upon layer with overlap between the layers. During this process the metal sheets are guided radially via guide rails (guide lines, wedge members) often constituting supporting links between the core and the stator body. In conventional types of large rotating electric machines, the metal sheets are held together axially by means of clamping devices in the form of pressure brackets that are pressed by clamping means against pressure rings, pressure fingers or pressure segments. Clamping devices of conventional type are difficult to produce with the use of high-voltage cables.

Object of the invention:

The object of the present invention is to eliminate previous axial clamping devices and to provide a stator for a rotating electric machine having a homogeneous, non-deformable and sufficiently strong stator core without such devices. The object is also to provide a method for the manufacture of a stator of the type described above. The object is also to provide a rotating electric machine incorporating such a stator.

Summary of the invention:

The object of the present invention is to solve the problems mentioned above. This is achieved with a stator for a rotating electric machine as defined in claim 1, a method of manufacturing a stator for a rotating electric machine as defined in claim 15, and a rotating electric machine incorporating a stator of the above type as defined in claim 30. The rotating electric machine comprises windings. The stator according to the present invention comprises a stator body and a stator core consisting of stator teeth extending radially inwards from an outer yoke portion. The stator core is composed of a number of packs, each of which includes a number of metal sheets, or of a number of metal sheets, the packs or metal sheets being stacked on and partially overlapping each other. The packs or metal sheets are secured radially by means of wedge members arranged at the stator body. The stator is also characterized in that the windings are drawn through slots in the stator and consist of a high-voltage cable, and in that the packs or metal sheets are secured axially by means of hot-setting adhesive members arranged between them.

The method for manufacturing a stator for a rotating electric machine according to the present invention comprises the following steps:

- applying a hot-setting adhesive member on at least one side of each pack or each metal sheet prior to assembly of the stator;
- stacking the packs or metal sheets on top of and partially overlapping each other to form different layers of packs or metal sheets, with the aid of wedge members arranged at the stator body to radially secure the packs or metal sheets;
- when all packs or metal sheets are assembled, applying temporary clamping devices to press the packs or metal sheets together;
- applying heat-insulating members around the stator;
- heating the stator core with the aid of heat-generating means to a setting temperature for the adhesive members and maintaining said temperature until the adhesive members have hardened.

According to the present invention a stator is obtained wherein the stator core is homogeneous, non-deformable and sufficiently strong without the use of axial clamping devices.

Thanks to said method of manufacturing a stator for a rotating electric machine according to the present invention, the stator core can be manufactured either at the factory or on site and eliminates the need for special axial clamping devices.

In the stator according to the invention the windings are preferably of a type corresponding to cables with

solid, extruded insulation, such as those used nowadays for power distribution, e.g. XLPE-cables or cables with EPR-insulation. Such a cable comprises an inner conductor composed of one or more strand parts, an inner semiconducting layer surrounding the conductor, a solid insulating layer surrounding this and an outer semiconducting layer surrounding the insulating layer. Such cables are flexible, which is an important property in this context since the technology for the device according to the invention is based primarily on winding systems in which the winding is formed from cable which is bent during assembly. The flexibility of a XLPE-cable normally corresponds to a radius of curvature of approximately 20 cm for a cable 30 mm in diameter, and a radius of curvature of approximately 65 cm for a cable 80 mm in diameter. In the present application the term "flexible" is used to indicate that the winding is flexible down to a radius of curvature in the order of four times the cable diameter, preferably eight to twelve times the cable diameter.

The winding should be constructed to retain its properties even when it is bent and when it is subjected to thermal stress during operation. It is vital that the layers retain their adhesion to each other in this context. The material properties of the layers are decisive here, particularly their elasticity and relative coefficients of thermal expansion. In a XLPE-cable, for instance, the insulating layer consists of cross-linked, low-density polyethylene, and the semiconducting layers consist of polyethylene with soot and metal particles mixed in. Changes in volume as a result of temperature fluctuations are completely absorbed as changes in radius in the cable and, thanks to the comparatively slight difference between the

coefficients of thermal expansion in the layers in relation to the elasticity of these materials, radial expansion can take place without the adhesion between the layers being lost.

The material combinations stated above should be considered only as examples. Other combinations fulfilling the conditions specified and also the condition of being semiconducting, i.e. having resistivity within the range of 10^{-1}-10^{6} ohm-cm, e.g. 1-500 ohm-cm, or 10-200 ohm-cm, naturally also fall within the scope of the invention.

The insulating layer may consist, for example, of a solid thermoplastic material such as low-density polyethylene (LDPE), high-density polyethylene (HDPE), polypropylene (PP), polybutylene (PB), polymethyl pentene (PMP), cross-linked materials such as cross-linked polyethylene (XLPE), or rubber such as ethylene propylene rubber (EPR) or silicon rubber.

The inner and outer semiconducting layers may be of the same basic material but with particles of conducting material such as soot or metal powder mixed in.

The mechanical properties of these materials, particularly their coefficients of thermal expansion, are affected relatively little by whether soot or metal powder is mixed in or not - at least in the proportions required to achieve the conductivity necessary according to the invention. The insulating layer and the semiconducting layers thus have substantially the same coefficients of thermal expansion.

Ethylene-vinyl-acetate copolymers/nitrile rubber, butyl graft polyethylene, ethylene-butyl-acrylate-copolymers and ethylene-ethyl-acrylate copolymers may also

constitute suitable polymers for the semiconducting layers.

Even when different types of material are used as base in the various layers, it is desirable for their coefficients of thermal expansion to be substantially the same. This is the case with combination of the materials listed above.

The materials listed above have relatively good elasticity, with an E-modulus of $E<500$ MPa, preferably <200 MPa. The elasticity is sufficient for any minor differences between the coefficients of thermal expansion for the materials in the layers to be absorbed in the radial direction of the elasticity so that no cracks appear, or any other damage, and so that the layers are not released from each other. The material in the layers is elastic, and the adhesion between the layers is at least of the same magnitude as the weakest of the materials.

The conductivity of the two semiconducting layers is sufficient to substantially equalize the potential along each layer. The conductivity of the outer semiconducting layer is sufficiently great to enclose the electrical field in the cable, but sufficiently small not to give rise to significant losses due to currents induced in the longitudinal direction of the layer.

Thus, each of the two semiconducting layers essentially constitutes one equipotential surface and the winding, with these layers, will substantially enclose the electrical field within it.

There is, of course, nothing to prevent one or more additional semiconducting layers being arranged in the insulating layer.

The invention will now be explained in more detail in the following description of preferred embodiments thereof with reference to the accompanying drawings.

Brief description of the drawings:

Figure 1 shows a cross section through a high-voltage cable,

Figure 2 shows a schematic view in perspective of a section taken diametrically through a stator in a rotating electric machine in accordance with the state of the art,

Figure 3 shows schematically a radial sector of a rotating electric machine;

Figure 4 shows a flow chart for a method of manufacturing the stator of a rotating electric machine according to the present invention;

Figure 5 shows the application of adhesive members on metal sheet in accordance with a first embodiment of the method according to Figure 4;

Figure 6 shows a cross section through a metal sheet treated in accordance with Figure 5;

Figure 7 shows the application of adhesive members on metal sheet according to a second embodiment of the method according to Figure 4;

Figure 8 shows a cross section of a metal sheet treated in accordance with Figure 7;

Figure 9 shows schematically the intermediate compression step when laying the laminations of the stator core;

Figure 10 shows schematically how the metal sheet is laid when assembling the stator core;

Figure 11 shows schematically vibration settling when laying the laminations of the stator core;

Figure 12 shows schematically an example of the hardening step in the method according to Figure 4.

Detailed description of embodiments of the present invention:

Figure 1 shows a cross section through a high-voltage cable 10 used traditionally for transmitting electric power. The high-voltage cable 10 illustrated may be a standard XLPE cable, for instance, 145 kV, but without sheath or screen. The high-voltage cable 10 consists of an electric conductor composed of one or more strand parts 12 made of copper (Cu), for instance, and having circular cross section. These strand parts are arranged in the middle of the cable 10. Around the strand parts 12 is a first semiconducting layer 14. Around the first semiconducting layer 14 is a first insulating layer 16, e.g. XLPE-insulation, and around the first insulating layer 16 is a second semiconducting layer 18.

Figure 2 shows a schematic view in perspective of a section taken diametrically through a stator 20 of a rotating electric machine according to the state of the art. In this figure the rotor in the rotating electric machine has been removed to facilitate understanding of

how the stator 20 is arranged. The main parts of the stator comprise a stator body 22, a stator core 24 including stator teeth 26 and a stator yoke 28. The stator 20 also includes a stator winding 30 formed of high-voltage cable, placed in a space 32 shaped like a bicycle chain, see Figure 3, between each individual stator tooth 26. The stator winding 30 in Figure 3 is only indicated by its electric conductors. As can be seen in Figure 2, the stator winding 30 forms a coil-end package 34 at each side of the stator 20. Figure 3 also reveals that the cable is stepped in several dimensions, depending on its radial position in the stator 20. The stator core 24 comprises a number of packs containing a number of metal sheets 38 glued together (see Figure 3), or a number of metal sheets 38 (see Figure 3), the packs 38 or metal sheets 38 being stacked on and partially overlapping each other, i.e. they are placed in a ring, layer upon layer, with overlap between the layers. The packs 38 or metal sheets 38 are guided and secured radially by means of wedge members arranged at the stator body 22. These wedge members are also known as guide lines and often constitute supporting links between the stator core 24 and stator body 22. In the case of large rotating electric machines, the packs 38 or metal sheets 38 are conventionally held together in axial directions by means of clamping devices in the form of pressure brackets 36 pressed by clamping means against pressure rings, pressure fingers or pressure segments. Only two pressure brackets 36 have been drawn in in Figure 2. A stator according to the present invention is similar in appearance to the stator 20 shown in Figure 2. The visible difference is that the stator according to the present invention does not have any pressure brackets 36. Instead, the packs 38 or metal sheets 38 are

secured in axial direction by means of hot-setting adhesive members (See Figures 5 and 7).

Figure 3 shows schematically a radial sector of a rotating electric machine with a pack 38 or metal sheet 38 of the stator 20, and with a rotor pole 40 on the rotor 42 of the machine. It is also clear that the stator winding 30 is arranged in a space 32 shaped like a bicycle chain, formed between teach stator tooth 26.

Figure 4 shows a flow chart for a method for manufacturing a stator 20 for a rotating electric machine according to the present invention. The stator 20 comprises a stator body 22, a stator core 24 including a number of packs 38, each comprising a number of metal sheets, or a number of metal sheets 38. The method commences at block 50, and is followed at block 52 by the step of applying a hot-setting adhesive member on at least one side of each pack 38 or metal sheet 38 prior to assembly of the stator 20. Next, at block 54, the packs 38 or metal sheets 38 are assembled, stacked on and partially overlapping each other and forming different layers with packs 38 or metal sheets, with the aid of wedge members arranged at the stator body 22 to secure the packs 38 or metal sheets 38 radially. The procedure then continues at block 56, when all packs 38 or metal sheets 38 are assembled, by the application of temporary clamping devices to press together the packs 38 or metal sheets 38. Then, at block 58, the procedure continues with heat-insulating members being placed around the stator 20. Thereafter, at block 60, the stator core 20 is heated with the aid of heat-generating means to a temperature sufficient to cure the adhesive members. The stator core 20 is kept hot until the adhesive members have cured. The procedure is complete at block

62. After this step windings (30) consisting of a high-voltage cable (10) are drawn through slots in the stator. The windings (30) consists of at least one turn of continuous high-voltage cable (10).

The method according to the present invention may also include the step of at least once during the assembly step (block 54 in Figure 4) compacting the partly or wholly assembled stator core 20 in axial direction. This may be effected by means of a pressure arrangement. (See Figure 9.) An alternative is for the compacting step to include the following steps: 1) winding a number of turns of cable around the partially or wholly assembled stator core 20; 2) supplying the cable with an appropriate alternating current to vibrate the stator core (20), thus homogenising it. (See Figure 11.) The step of applying adhesive members (block 52 in Figure 4) may include the following steps: 1) applying a hot-setting adhesive layer on at least one side of each pack 38 or each metal sheet 38 with the aid of an application device; 2) drying the adhesive layer with the aid of dryers. (See Figure 5.) The method may also include the steps of: 1) before block 52, applying an insulating varnish layer by means of varnish spray nozzles on both sides of each pack 38 or each metal sheet 38; 2) drying the layer of insulating varnish with the aid of dryers. (See Figure 5.) An alternative is to apply a hot-setting adhesive layer by means of glue nozzles. (See Figure 5.) Another alternative is for the adhesive layer to be applied by means of smearing. Yet another alternative is to apply the adhesive layer by brush. An alternative method of performing the step of applying adhesive members (block 52 in Figure 4) is to apply a hot-setting adhesive foil on at least one side of each

pack 38 or each metal sheet 38. (See Figure 7.) The adhesive foil may applied by being rolled in with a roller. (See Figure 7.) Another alternative is for the adhesive foil to be applied by means of pressure. Yet another alternative is for the adhesive foil to be applied by melting. According to one embodiment the adhesive foil is applied on a metal strip, after which metal sheets 38 are punched out with a metal punch. The method according to the present invention may also include the step of applying a layer of insulating varnish on the side without adhesive foil, after application of the adhesive foil.

Figure 5 shows application of adhesive members on metal sheets 38 in accordance with a first embodiment of the method according to Figure 4. In this example the metal sheets 38 are already punched out. The metal sheets 38 are lifted from a store 70 onto the conveyor belt 72. The metal sheets 38 are then deburred in a deburring machine 74. Thereafter a layer of insulating varnish is applied on the metal sheets by varnish spray nozzles 76 and the layer is dried by dryers 78. In the example shown the dryers 78 consist of infra lamps 78. An application means 80 applies adhesive to the metal sheets 38. In this example the application means 80 comprises a glue spray nozzle 80 used to apply the adhesive layer on the metal sheet 38. The adhesive layer is then dried by dryers 82, e.g. infra lamps 82. The finished metal sheets 38 are collected in the store 84. The metal sheets 38 can be handled when the adhesive layer has dried. The glue used is a hot-setting glue that may have a solvent base or be soluble in water.

Figure 6 shows a cross section of a metal sheet 38 treated in accordance with Figure 5. Nearest the sheet

38 are the first layers 86 of varnish, applied on metal strip by the manufacturer. The second varnish layers 88 are applied at after-varnishing and correspond to the insulating varnish layers applied in Figure 5. Outermost is the adhesive layer 90. A typical thickness of the metal sheets 38 is 0.35 - 0.50 mm Characteristically the first and second layers of varnish 86, 88 have a total thickness of 0.005 - 0.010 mm. The adhesive layer 90 is typically 0.005 mm thick.

Figure 7 shows application of adhesive members on metal sheets according to a second embodiment of the method according to Figure 4. In this figure the adhesive members are applied before the metal sheets 38 are punched out of the metal strip. Varnished metal strip 92 is rolled out from a first drum 94. Adhesive foil 96 is rolled from a second drum 98 and rolled in, e.g. with the aid of a roller 100. The metal strip continues to a sheet-metal punch 102 where metal sheets 38 are punched out. The spillage is rolled up on a third drum 104 and the metal sheets 38 are transported on conveyor belt 106 to the store 108.

Figure 8 shows a cross section of a metal sheet treated in accordance with Figure 7. The metal sheets have been de-burred after punching, and after-varnished on the side without adhesive. Nearest the sheet 38 are varnish layers 86, applied on the metal strip 92 at the manufacturer's. The varnish layer 88 was applied at after-varnishing. The adhesive foil applied is designated 96. The adhesive foil 96 may also be applied by means of pressure or by melting. The adhesive foil 96 used is of hot-setting type.

Figure 9 shows schematically the intermediate compression step when laying the laminations of the stator core 24. The stator core 24 is assembled in an aligned stator body 22, possibly screwed together, in perfectly conventional manner. The metal sheets 38 are guided radially by wedge members (guide lines) 110. If metal sheets 38 with adhesive applied on only one side are used, it is important that all metal sheets 38 are placed with the glue side up or all sheets 38 with the glue side down. When a suitable number of lamination layers have been laid, intermediate compression can be performed in order to homogenise the stator core 24. In the example shown, the lower side of the stator core 24 is supported by plates 112 and pallets 114. In Figure 9 a pressure device 116 is used to compact the stator core 24.

Figure 10 shows schematically how the metal sheets 38 are laid during assembly of a stator core 24. The metal sheets 38 are laid layer upon layer, the metal sheets 38 in different layers partially overlapping each other. The metal sheets 38 are guide radially by wedge members 110.

Figure 11 shows schematically vibration settling when laying the laminations of the stator core 24. If homogenisation of the stator core 24 is unsatisfactory, it can be improved by vibrating the laminated core 24 to obtain better settling. Compression and vibration of the core 24 shall possibly be performed on the completed stator core 24. Cable 118 is wound a suitable number of cable turns around the stator core 24. Supplying the cable 118 with alternating current at suitable voltage and current strength will cause the stator core 24 to start vibrating, thus adjusting the

metal sheets 38 to each other so that the stator core 24 "settles" and becomes more homogeneous.

Figure 12 shows schematically an example of the curing step (block 60 in Figure 4) in the method according to Figure 4. When the stator core 24 is complete, the metal sheets 38 are compressed axially by means of temporary clamping devices 120, 122 which, in the example shown, consist of plates 120 and bolts 122. The pressure exerted by the clamping devices 120, 122 shall be maintained throughout the curing process. Prior to curing, heat-insulating members 124 are placed around the stator 20. The heat-insulating member 124 may comprise a heat-insulating cover (tent) 124 that protects the stator 20 from cooling down during the curing process. Heat-generating means 126 are applied around the stator core 124 to heat it to the correct curing temperature - roughly 80-200°C - and to maintain this temperature throughout the curing period - roughly 1-20 hours. Hot-air units or heating mats may be used as heat-generating means 126. During the curing process individual metal sheets 38 are bound (glued) together to form a strong, homogeneous stator core 24.

Although the drawings show the invention as applicable to individual metal sheets, it is also suitable for use with packs comprising a number of metal sheets glued together.

The invention is not limited to the embodiments shown. Several modifications are feasible within the scope of the appended claims.

CLAIMS

1. A stator (20) in a rotating electric machine, wherein the stator (20) is composed of a stator body (22), a stator core (24) comprising stator teeth (26) extending radially inwards from an outer yoke portion (28), said stator core (24) consisting of a number of packs (38), each of which includes a number of metal sheets, or of a number of metal sheets (38), each pack (38) or metal sheet (38) being stacked on top of and partially overlapping each other, said packs (38) or metal sheets (38) being secured radially by means of wedge members (110) arranged at the stator body (22), characterized in that the windings (30) are drawn through slots in the stator and consist of high-voltage cable (10), and in that the packs (38) or metal sheets (38) are secured axially by means of hot-setting adhesive members (90; 96) arranged between them.

2. A stator (20) in a rotating electric machine as claimed in claim 1, characterized in that the high-voltage cable (10) comprises an electric conductor having one or more strand parts (12), a first semiconducting layer (14) surrounding the electric conductor, an insulating layer (16) surrounding the first semiconducting layer (14), and a second semiconducting layer (18) surrounding the insulating layer (16).

3. A stator (20) in a rotating electric machine as claimed in claim 2, characterized in that the high-voltage cable (10) has a diameter within the interval 20-200 mm and a conducting area within the interval 80-3000 mm^2.

4. A stator (20) in a rotating electric machine as claimed in any of claims 1-3, characterized in that the adhesive members (90; 96) are arranged with the main spreading area on both sides of each pack (38), or with the main spreading area on both sides of each metal sheet (38).

5. A stator (20) in a rotating electric machine as claimed in any of claims 1-3, characterized in that the adhesive members (90; 96) are arranged with the main spreading area on one side of each pack (38), or with the main spreading area on one side of each metal sheet (38).

6. A stator (20) in a rotating electric machine as claimed in any of claims 1-5, characterized in that the adhesive member (90) consists of hot-setting adhesive (90) applied prior to assembly of the stator.

7. A stator (20) in a rotating electric machine as claimed in any of claims 1-5, characterized in that the adhesive member (96) consists of hot-setting adhesive foil (96) applied prior to assembly of the stator (20).

8. A stator (20) in a rotating electric machine as claimed in any of claims 1-5, characterized in that the adhesive member (96) consists of molten adhesive (96) applied prior to assembly of the stator (20).

9. A stator (20) in a rotating electric machine as claimed in claim 2, characterized in that the windings are flexible and in that said layers adhere to each other.

10. A stator (20) in a rotating electric machine as claimed in claim 9, characterized in that said layers consist of materials with such elasticity and such a relation between the coefficients of thermal expansion that the changes in volume in the layers caused by temperature fluctuations during operation are absorbed by the elasticity of the materials so that the layers retain their adhesion to each other at the temperature fluctuations occurring during operation.

11. A stator (20) in a rotating electric machine as claimed in claim 10, characterized in that the materials in said layers have high elasticity, preferably with an E-modulus less than 500 MPa, most preferably less than 200 MPa.

12. A stator (20) in a rotating electric machine as claimed in claim 10, characterized in that the coefficients of thermal expansion for the materials in said layers are of substantially the same magnitude.

13. A stator (20) in a rotating electric machine as claimed in claim 10, characterized in that the adhesion between the layers is of at least the same magnitude as in the weakest of the materials.

14. A stator (20) in a rotating electric machine as claimed in claim 9 or claim 10, characterized in that each of the semiconducting layers essentially constitutes one equipotential surface.

15. A method of manufacturing a stator (20) for a rotating electric machine with windings (30), wherein the stator (20) is composed of a stator body (22), a stator core (24) consisting of a number of packs (38), each of which includes a number of metal sheets, or of

a number of metal sheets (38), the method comprising the following steps:

- applying a hot-setting adhesive member (90; 96) on at least one side of each pack (38) or each metal sheet (38) prior to assembly of the stator (20);
- stacking the packs (38) or metal sheets (38) on top of and partially overlapping each other to form different layers of packs (38) or metal sheets (38), with the aid of wedge members (110) arranged at the stator body (22) to radially secure the packs (38) or metal sheets (38);
- when all packs (38) or metal sheets (38) are assembled, applying temporary clamping devices (120, 122) to press the packs (38) or metal sheets (38) together;
- applying heat-insulating members (124) around the stator (20);
- heating the stator core (24) with the aid of heat-generating means (126) to a setting temperature for the adhesive members (90; 96) and maintaining said temperature until the adhesive members (90; 96) have hardened.

16. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 15, characterized in that the method also includes the step:

- at least once during the assembly step compacting the partly or wholly assembled stator core (24) in axial direction.

17. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 16, characterized in that the compacting step is performed by means of a compression device (116).

18. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 16, characterized in that the compacting step also includes the steps of:

- winding a number of turns of cable (118) around the partially or wholly assembled stator core (24)
- supplying the cable (118) with an appropriate alternating current to vibrate the stator core (24), thus homogenising it.

19. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in any of claims 15-18, characterized in that the step of applying adhesive members (90) also includes the following steps:

- applying a hot-setting adhesive layer (90) on at least one side of each pack (38) or each metal sheet (38) with the aid of an application device (80); and
- drying the adhesive layer (90) with the aid of dryers (82).

20. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 19, characterized in that the method also includes the steps of:

- applying an insulating varnish layer (88) by means of varnish spray nozzles (76) on both sides of each pack (38) or each metal sheet (38), prior to the step of applying a hot-setting adhesive layer (90); and

- drying the layer (88) of insulating varnish with the aid of dryers (78).

21. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in either of claims 19 or 20, characterized in that the step of applying a hot-setting adhesive layer (90) comprises the following step:

- applying the adhesive layer (90) with the aid of adhesive spray nozzles (80).

22. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in either of claims 19 or 20, characterized in that the adhesive layer (90) is applied by means of smearing.

23. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in either of claims 19 or 20, characterized in that the adhesive layer (90) is applied by brush.

24. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in any of claims 15-20, characterized in that the step of applying adhesive members (96) comprises the following step:

- applying a hot-setting adhesive foil (96) on at least one side of each pack (38) or each metal sheet (38).

25. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 24, characterized in that the adhesive foil (96) is applied by being rolled in with a roller (100).

26. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 24, characterized in that the adhesive foil (96) is applied by means of pressure.

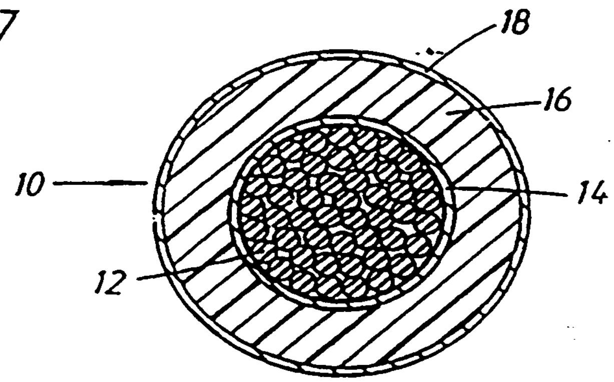
27. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in claim 24, characterized in that the adhesive foil (96) is applied by melting.

28. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in any of claims 24-27, characterized in that the adhesive foil (96) is applied on a metal strip (92), after which metal sheets (38) are punched out.

29. A method of manufacturing a stator (20) for a rotating electric machine, as claimed in any of claims 24-28, characterized in that after application of the adhesive foil (96), a layer (88) of insulating varnish is applied on the side without the adhesive foil (96).

30. A rotating electric machine incorporating a stator (20) as claimed in any of claims 1-14.

Fig. 1



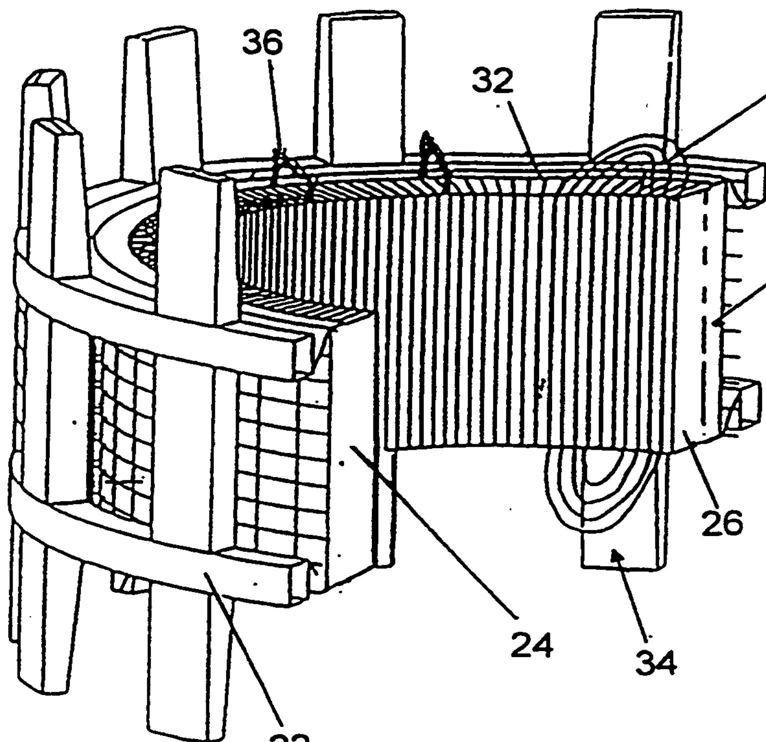


Fig. 2

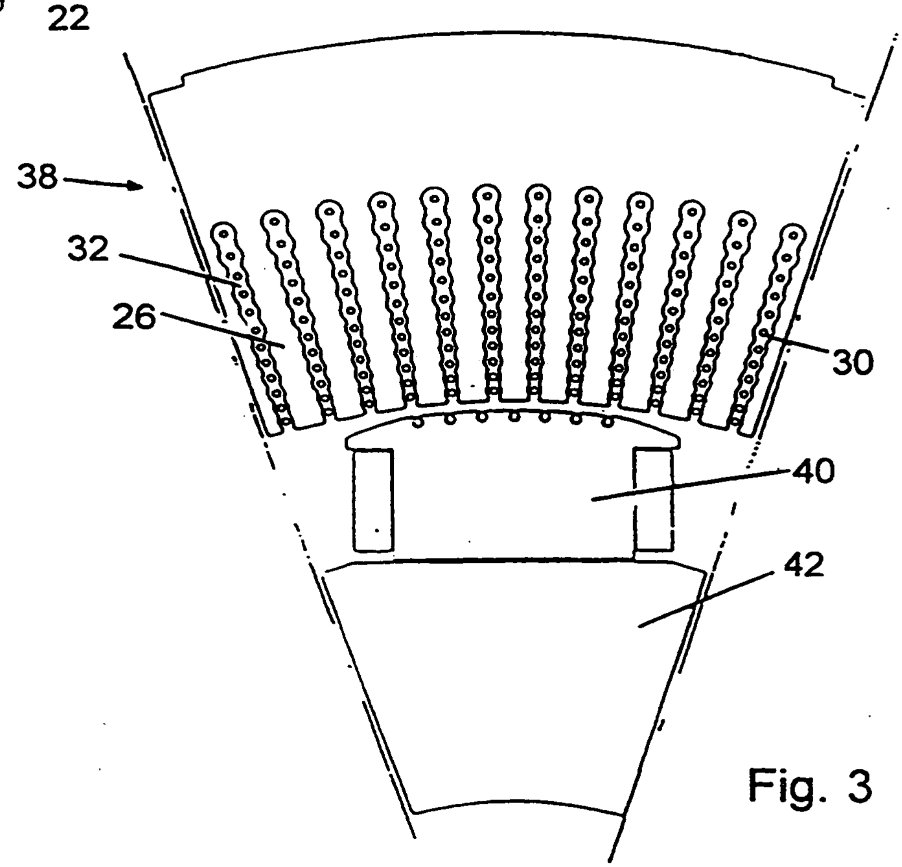


Fig. 3

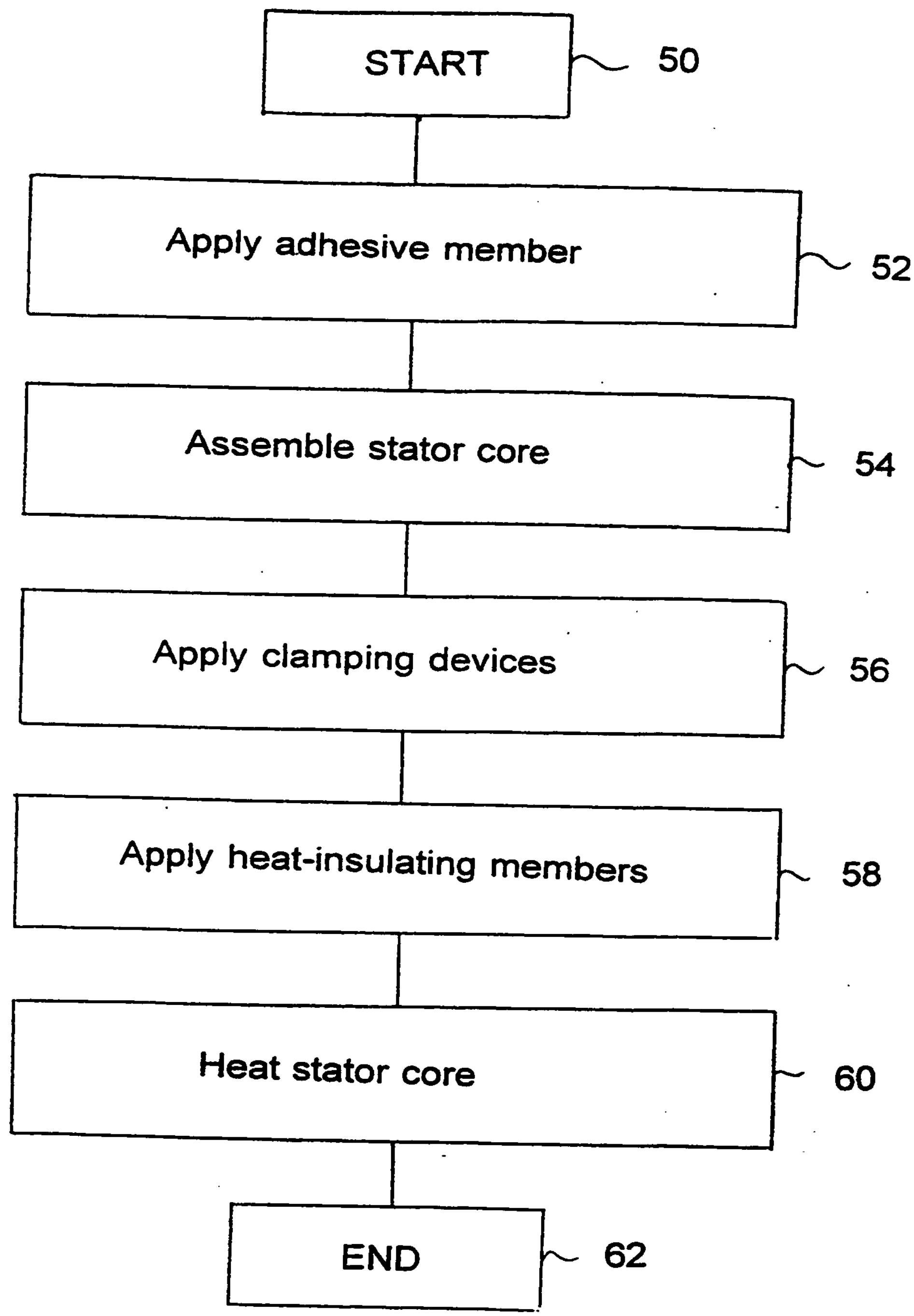

START
50
Apply adhesive member
52
Assemble stator core
54
Apply clamping devices
56
Apply heat-insulating members
58
Heat stator core
60
END
62

Fig. 4

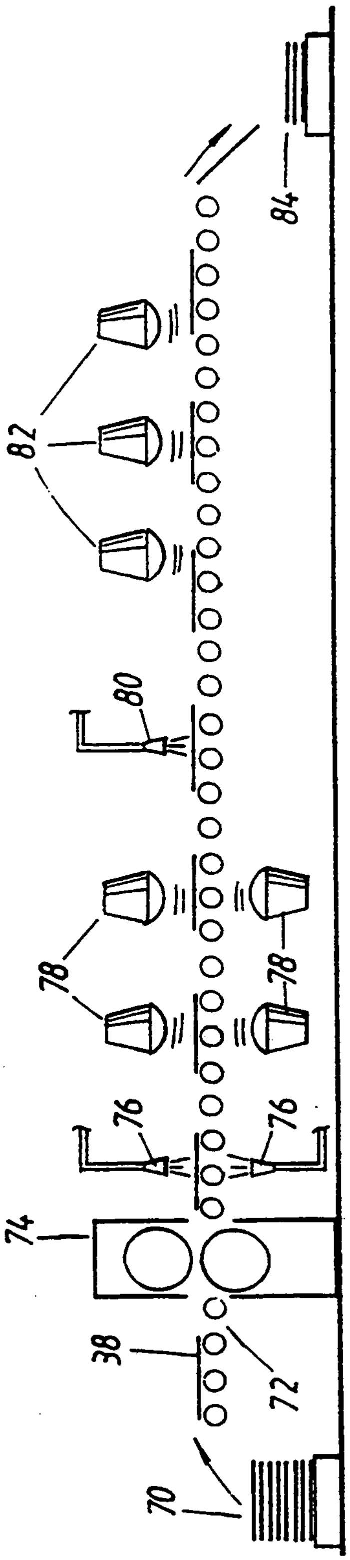


Fig. 5

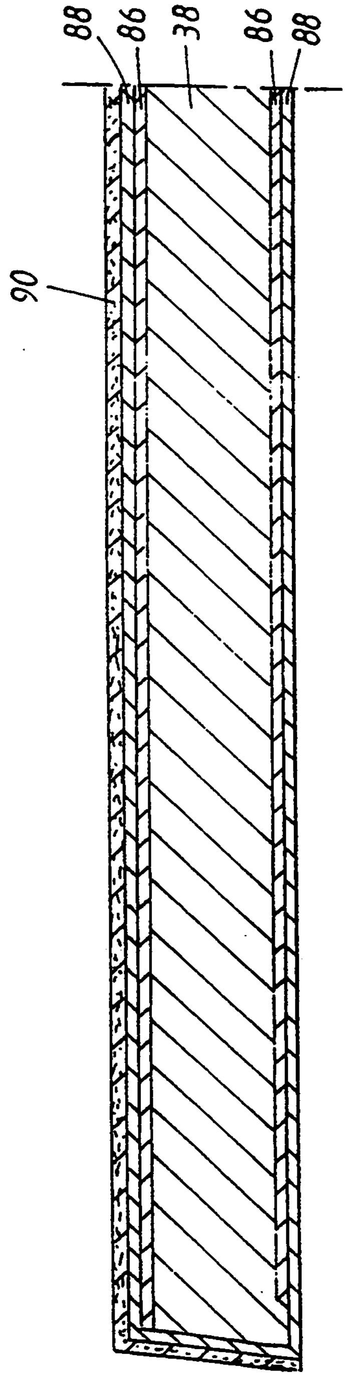


Fig. 6

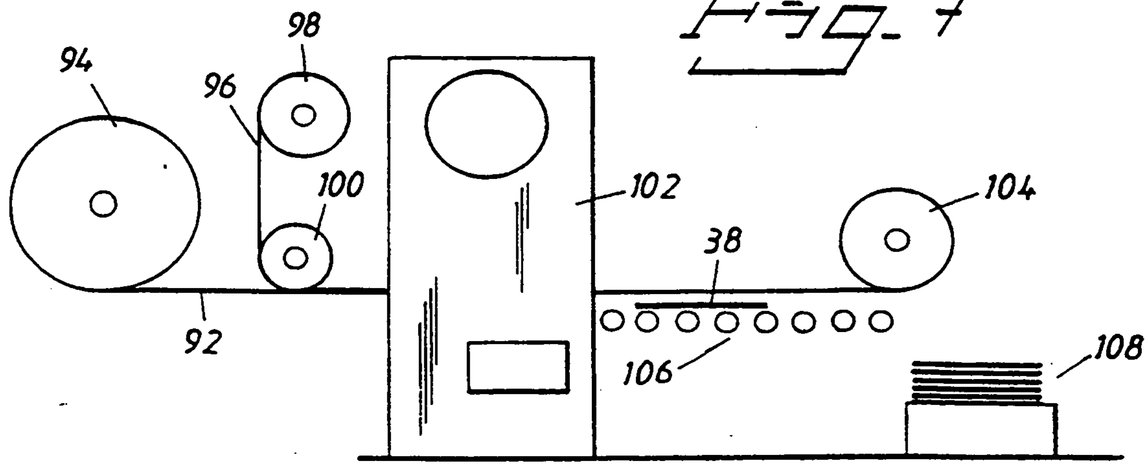


Fig. 7

Fig. 8

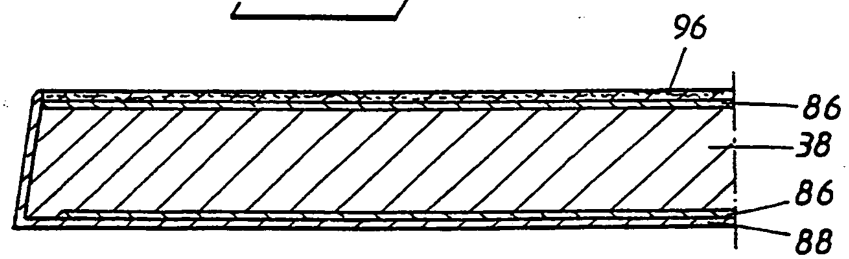
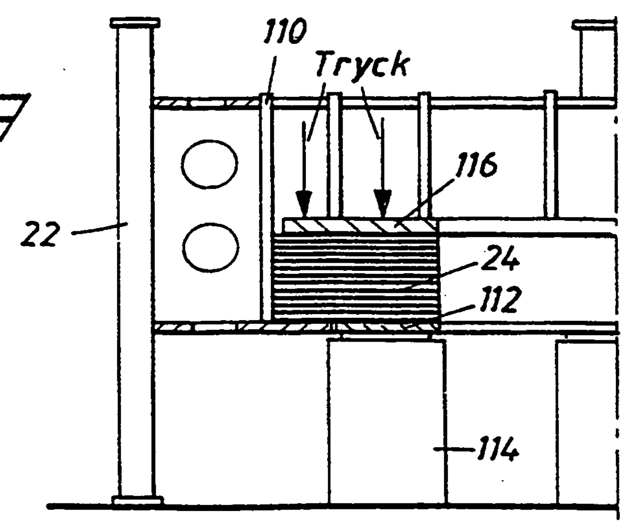


Fig. 9



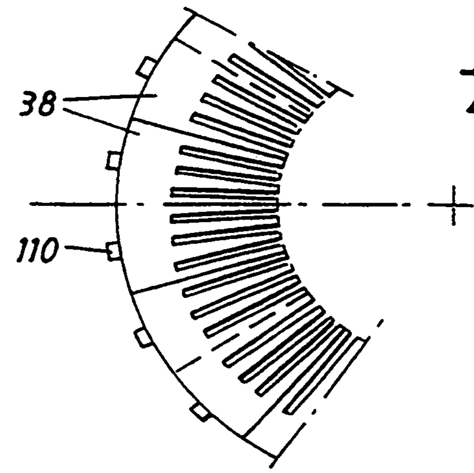


Fig.10

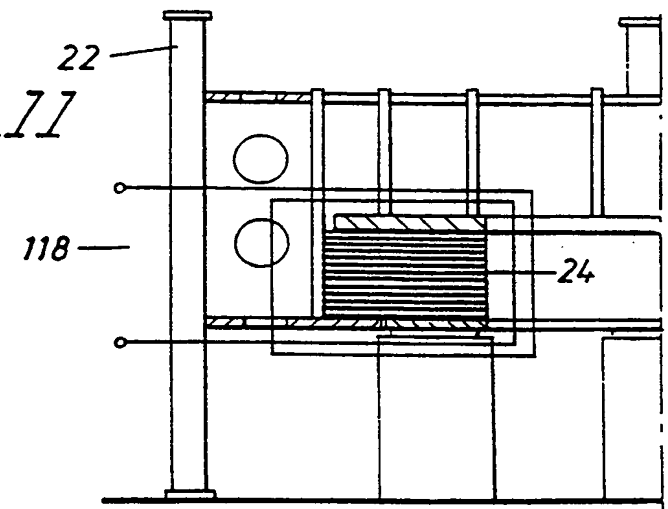


Fig.11

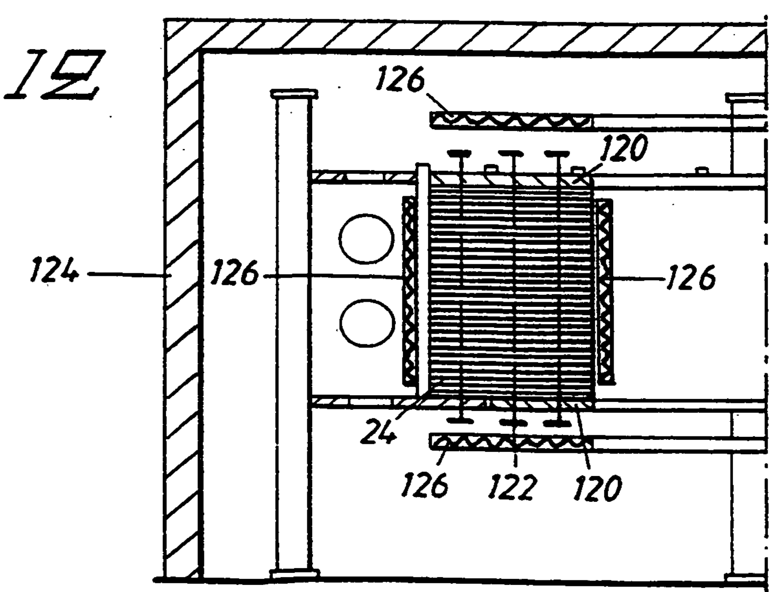


Fig.12

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00168

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H02K 15/02, H02K 1/12
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0406437 A1 (FANUC LTD), 9 January 1991 (09.01.91), claims 1-3, abstract --	1-8,10-19, 22-30
X	US 4085347 A (LICHIUS), 18 April 1978 (18.04.78), abstract --	1-8,10-19, 22-30
X	US 5168662 A (NAKAMURA ET AL.), 8 December 1992 (08.12.92), abstract --	1-8,10-19, 22-30
A	US 5036165 A (ELTON ET AL.), 30 July 1991 (30.07.91), abstract -- --------	9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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"E" erlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 July 1998	20 -07- 1998
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Tycho Beckman Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/06/98

International application No.

PCT/SE 98/00168

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